CLAIMS

1. A catalyst designed for use in a catalytic system, the catalyst comprising an ordered intermetallic compound.

2. The catalyst of claim 1, wherein the ordered intermetallic compound comprises platinum.

3. The catalyst of claim 2, wherein the ordered intermetallic compound is selected from the group consisting of BiPt, Bi_2Pt, PtIn, PtPb, PtGe, $PtIn_2$, $PtIn_3$, Pt_3In_7, PtSn, $PtSn_2$, Pt_3Sn, Pt_2Sn_3, $PtSn_4$, PtSb, $PtSb_2$, PtGa, $PtCd_2$, and PtMn.

4. The catalyst of claim 2, wherein the ordered platinum intermetallic compound is BiPt or Bi_2Pt.

5. The catalyst of claim 2, wherein the ordered platinum intermetallic compound is PtPb.

6. The catalyst of claim 2, wherein the ordered platinum intermetallic compound is PtIn.

7. The catalyst of claim 1, wherein the catalytic system is a fuel cell.

8. The catalyst of claim 1, wherein the catalytic system is a fuel reformer.

9. The catalyst of claim 1, wherein the ordered intermetallic compound is a ternary compound.

10. The catalyst of claim 1, wherein the ordered intermetallic compound comprises palladium.

11. The catalyst of claim 10, wherein the ordered intermetallic compound is selected from the group consisting of PdGe, PdSb, and BiPd.

12. The catalyst of claim 1, wherein the ordered intermetallic compound comprises a first and a second element, wherein the stoichiometric ratio between the first and the second element is 1:1.

13. The catalyst of claim 1, wherein the ordered intermetallic compound has an interatomic nearest neighbor distances of greater than at least 3.0 Angstroms along at least one axis.

14. The catalyst of claim 1, wherein the ordered intermetallic compound oxidizes carbon monoxide.

15. A fuel cell comprising:
a first electrode that comprises an ordered intermetallic compound; and
a second electrode.

16. The fuel cell of claim 15, wherein the ordered intermetallic compound comprises platinum.

17. The fuel cell of claim 16, wherein the ordered intermetallic compound is selected from the group consisting of BiPt, Bi_2Pt, PtIn, PtPb, PtGe, $PtIn_2$, $PtIn_3$, Pt_3In_7, PtSn, $PtSn_2$, Pt_3Sn, Pt_2Sn_3, $PtSn_4$, PtSb, $PtSb_2$, PtGa, $PtCd_2$, and PtMn.

18. The fuel cell of claim 16, wherein the ordered platinum intermetallic compound is PtSn.

19. The fuel cell of claim 16, wherein the ordered platinum intermetallic compound is PtIn.

20. The fuel cell of claim 16, wherein the ordered platinum intermetallic compound is PtPb.

21. The fuel cell of claim 16, wherein the ordered intermetallic compound is BiPt or Bi_2Pt.

22. The fuel cell of claim 15, wherein the ordered intermetallic compound comprises palladium.

23. The fuel cell of claim 22, wherein the ordered intermetallic compound is selected from the group consisting of PdGe, PdSb, and BiPd.

24. The fuel cell of claim 15, wherein the ordered intermetallic compound is selected from the group consisting of IrBi, NiBi, and RhBi.

25. The fuel cell of claim 15, wherein the fuel cell is connectable to a source of fuel.

26. The fuel cell of claim 25, wherein the fuel is a small organic molecule fuel.

27. The fuel cell of claim 26, wherein the fuel is selected from the group consisting of formic acid, methanol, ethanol, ethylene glycol, 2 butyne 1,4diol, 2 butene 1,4diol, acetic acid, and oxalic acid.

28. The fuel cell of claim 25, wherein the fuel is hydrogen.

29. The fuel cell of claim 28, wherein the hydrogen comprises at least about 0.01 mole percent of carbon monoxide.

30. The fuel cell of claim 28, wherein the hydrogen comprises at least about 0.2 mole percent of carbon monoxide.

31. The fuel cell of claim 28, wherein the hydrogen comprises between about 3 mole percent and about 10 mole percent carbon monoxide.

32. The fuel cell of claim 15, wherein the first electrode is an anode.

33. The fuel cell of claim 15, wherein the first electrode is an cathode.

34. The fuel cell of claim 15, wherein the second electrode comprises an ordered intermetallic compound.

35. The fuel cell of claim 15, further comprising a separator between the first electrode and the second electrode.

36. The fuel cell of claim 35, wherein the separator is a proton exchange separator.

37. The fuel cell of claim 36, wherein the proton exchange separator is a membrane.

38. The fuel cell of claim 36, wherein the proton exchange separator is a liquid.

39. The fuel cell of claim 36, wherein the proton exchange separator comprises a polymeric material or a salt.

40. The fuel cell of claim 15, wherein the ordered intermetallic compound is a powder.

41. The fuel cell of claim 15, wherein the fuel is formic acid and the ordered intermetallic compound is BiPt.

42. The fuel cell of claim 15, wherein the fuel is formic acid and the ordered intermetallic compound is Bi_2Pt.

43. The fuel cell of claim 15, wherein the fuel is methanol and the ordered intermetallic compound is PtPb.

44. The fuel cell of claim 15, wherein the fuel is ethanol and the ordered intermetallic compound is PtPb.

45. The fuel cell of claim 15, wherein the fuel is formic acid and the ordered intermetallic compound is PtPb.

46. The fuel cell of claim 15, wherein the fuel is methanol and the ordered intermetallic compound is PtIn.

47. The fuel cell of claim 15, wherein the fuel is ethanol and the ordered intermetallic compound is PtIn.

48. The fuel cell of claim 15, wherein the fuel is formic acid and the ordered intermetallic compound is PtIn.

49. A hydrogen fuel cell comprising:

a first electrode; and

a second electrode,

wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide when operating for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least about 20% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide when operating for 30 minutes at the conditions.

50. The fuel cell of claim 49, wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel comprising greater than about 0.2 mole percent carbon monoxide when operating for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least about 20% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide when operating for 30 minutes at the conditions.

51. The fuel cell of claim 49, wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel comprising between about 3 mole percent and about 10 mole percent carbon monoxide when operating for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least about 20% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide when operating for 30 minutes at the conditions.

52. The fuel cell of claim 49, wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide when operating for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least 50% the maximum output power when oxidizing

hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide when operating for 30 minutes at the conditions.

53. The fuel cell of claim 49, wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide when operating for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least 90% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide when operating for 30 minutes at the conditions.

54. The fuel cell of claim 49, wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel further comprising greater than about 0.0001 mole sulfur when operating at conditions including 80 degrees C for 30 minutes at a maximum output power of at least 20% the maximum output power of the same hydrogen fuel cell when oxidizing hydrogen fuel comprising less than about 0.00001 mole percent sulfur when operating at 80 degrees C for 30 minutes at the conditions.

55. The fuel cell of claim 49, wherein at least one of the electrodes comprises an ordered intermetallic compound.

56. The fuel cell of claim 55, wherein the ordered intermetallic compound comprises platinum.

57. A hydrogen fuel cell comprising:

an anode; and

a cathode,

wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide when operating for 30 minutes at conditions including a temperature of 80 degrees C or less to produce a current density per unit surface area of the cathode of at least about 0.05 Amp/sq. cm.

58. The hydrogen fuel cell of claim 57, wherein the current density per unit surface area of the cathode is at least about 0.1 Amp/sq. cm.

59. The hydrogen fuel cell of claim 57, wherein the current density per unit surface area of the cathode is at least about 1.0 Amp/sq. cm.

60. The hydrogen fuel cell of claim 57, wherein the anode comprises an ordered intermetallic compound.

61. The hydrogen fuel cell of claim 57, wherein the cathode comprises an ordered intermetallic compound.

62. The fuel cell of claim 60, wherein the ordered intermetallic compound comprises platinum.

63. A method comprising:

oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide in a fuel cell for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least 20% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide in the fuel cell for 30 minutes at the conditions.

64. The method of claim 63 comprising oxidizing hydrogen fuel comprising greater than about 0.2 mole percent carbon monoxide in the fuel cell for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least 20% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide in the fuel cell for 30 minutes at the conditions.

65. The method of claim 63 comprising oxidizing hydrogen fuel comprising between about 3 mole percent and about 10 mole percent carbon monoxide in the fuel cell for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least 20% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide in the fuel cell for 30 minutes at the conditions.

66. The method of claim 63 comprising oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide for 30 minutes in the fuel cell at conditions

including a temperature of 80 degrees C or less with a maximum output power of at least about 50% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide in the fuel cell for 30 minutes at the conditions.

67. The method of claim 63 comprising oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide in a fuel cell for 30 minutes at conditions including a temperature of 80 degrees C or less with a maximum output power of at least about 90% the maximum output power when oxidizing hydrogen fuel comprising less than about 0.0001 mole percent carbon monoxide in the fuel cell for 30 minutes at the conditions.

68. The method of claim 63, further comprising reforming a hydrocarbon to form the hydrogen fuel.

69. The method of claim 63, wherein the hydrogen fuel is not processed to reduce carbon monoxide concentration between the reforming step and the oxidizing step.

70. The method of claim 63, wherein oxidizing the hydrogen fuel is catalyzed using an ordered intermetallic compound.

71. The fuel cell of claim 70, wherein the ordered intermetallic compound comprises platinum.

72. A method comprising:

oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide for 30 minutes at conditions including a temperature of 80 degrees C or less to produce a current density per unit surface area of the cathode of at least about 0.05 Amp/sq. cm.

73. The method of claim 72 comprising oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide for 30 minutes at conditions including a temperature of 80 degrees C or less to produce a current density per unit surface area of the cathode of at least about 0.1 Amp/sq. cm.

74. The method of claim 72 comprising oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide for 30 minutes at conditions including a temperature of 80 degrees C or less to produce a current density per unit surface area of the cathode of at least about 1.0 Amp/sq. cm.

75. The method of claim 72, further comprising reforming a hydrocarbon to form the hydrogen fuel.

76. The method of claim 72, wherein the hydrogen fuel is not processed to reduce carbon monoxide concentration between the reforming step and the oxidation step.

77. The method of claim 72, wherein oxidizing the hydrogen fuel is catalyzed using an ordered intermetallic compound.

78. The method of claim 77, wherein the ordered intermetallic compound comprises platinum.

79. A method comprising:

oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide at conditions including a temperature of 80 degrees C, wherein the maximum output power after 30 minutes of operation is at least about 20% the maximum output power at the start of operation.

80. The method of claim 79, wherein the maximum output power after 30 minutes of operation is at least about 50% the maximum output power at the start of operation.

81. The method of claim 79, wherein the maximum output power after 30 minutes of operation is at least about 90% the maximum output power at the start of operation.

82. The method of claim 79, further comprising reforming a hydrocarbon to form the hydrogen fuel.

83. The method of claim 79, wherein the hydrogen fuel is not processed to reduce carbon monoxide concentration between the reforming step and the oxidation step.

84. The method of claim 79, wherein oxidizing the hydrogen fuel is catalyzed using an ordered intermetallic compound.

85. The method of claim 84, wherein the ordered intermetallic compound comprises platinum.

86. A hydrogen fuel cell comprising

a first electrode; and

a second electrode,

wherein the hydrogen fuel cell is capable of oxidizing hydrogen fuel comprising greater than about 0.01 mole percent carbon monoxide at conditions including a temperature of 80 degrees C or less at a maximum output power after 30 minutes of operation of at least about 20% the maximum output power at the start of operation.

87. The hydrogen fuel cell of claim 86, wherein the maximum output power after 30 minutes of operation of at least about 50% the maximum output power at the start of operation.

88. The hydrogen fuel cell of claim 86, wherein the maximum output power after 30 minutes of operation of at least about 90% the maximum output power at the start of operation.

89. The hydrogen fuel cell of claim 86, wherein oxidizing the hydrogen fuel is catalyzed using an ordered intermetallic compound.

90. The hydrogen fuel cell of claim 89, wherein the ordered intermetallic compound comprises platinum.